

GLCP: Grid-LEACH Clustering Protocol for Wireless Sensor Networks

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Abstract—Due to scarce battery power of Sensor Node(SNs) in Wireless Sensor Networks(WSN), number of energy efficient protocols has been proposed in literature. Clustering is energy efficient technique in which Sensor Nodes (SNs) are grouped into cluster and in every cluster, Cluster Head (CH) is responsible for transmitting aggregated data of its member SNs to Sink. In this paper we present Grid-LEACH protocol that implements LEACH protocol on grid-based network. Simulation results shows that Grid-LEACH protocol improve network lifetime in terms of overall energy consumption as compared to LEACH by reducing the number of transmitted packets to Base Station (BS).Main feature of Grid-LEACH protocol is that in case any grid left without CH then secondary CH is fixed for that grid.

Index Terms— Clustering, LEACH, Wireless Sensor Network, Cluster Head.

I. INTRODUCTION

Due to advancement in wireless technologies, WSN is considered as new technology for monitoring surroundings. Major applications of WSN includes military surveillance, forest fire detection, Habitat Monitoring, Home Control and industrial automation etc. [1]WSN consists of large number of SNs equipped with sensors, processor and radio unit. One of the major challenges[2] of WSN is to effectively utilize battery power of SN. Many energies efficient clustering protocols[3] has been proposed in literature to improve battery utilization of SN. This paper surveys the proposed clustering protocols during last few years.

Clustering is a process to divide SNs in clusters and every SN transmit its sense information to CH. Transmission is done by CH in order to reduce communication energy. Further CH sends aggregated data of its cluster to BS as shown in Figure 1.

Section I gives introduction of WSN and clustering process. Section II describes literature survey of Clustering protocol. Proposed Grid-LEACH clustering protocol has been discussed in section III. Section IV gives simulation and results. Conclusion and possible future research are proposed in Section V

II. LITERATURE SURVEY

This section discusses clustering protocols of last few years. Grid-based clustering protocol using hierarchal routing protocol has been proposed in [5]. Authors in [6] proposed chain-based clustering protocols. CH is selected based on energy, distance and node density parameters. Data transmit to CH through normal nodes

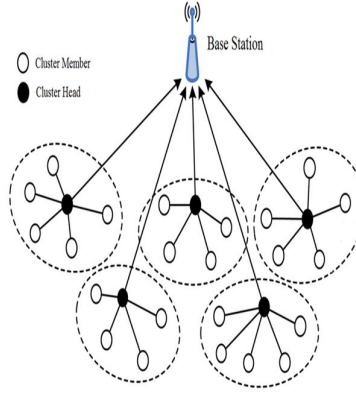


Figure 1: Clusters in WSN[4]

using single hop approach. Data transmitted to base station through cluster coordinator in type of chain. Authors compare proposed Improved CBCCP clustering protocol with CBCCP. Number of alive nodes are more and dead nodes are less in Improved CBCCP as compare to CBCCP. In [7] Heterogeneous clustering protocol has been introduced which divides SN into three groups normal, middle, and super based on their energy level. CHs are elected based on the probability function which is input of probability, total count and energy of normal, middle and super node. Proposed protocol performs better than LEACH, SAP and DEEC in terms of network lifetime and total count of CH and alive nodes. Multi-hop clustering protocol in [8] elect the CH based on genetic algorithm fitness function. Authors [9] presented the survey of improvements in LEACH protocols implemented during last few years.

III. GRID-LEACH CLUSTERING PROTOCOL

LEACH [10] is the most popular clustering protocol of WSN. Many LEACH based grid clustering protocols [11-13] have been introduced in literature to enhance network lifetime. LEACH clustering protocol consists of set-up phase and steady phase. The main drawback of LEACH protocol is that some area left without CHs due to its random nature. Clustering protocol Grid-LEACH is proposed to overcome this limitation up to some extent.

Grid-LEACH protocol consists of two phases set-up phase and steady phase. In set-up phase monitoring area is divided into equal size virtual grids and large numbers of SNs are deployed throughout the grids. In set-up phase primary CHs are selected based on the LEACH protocol equation shown in following equation

$$T(n) = \begin{cases} \frac{P}{1 - P * \left(r \bmod \frac{1}{P}\right)} : \text{if } n \in G \\ 0 : \text{otherwise} \end{cases} \quad (1)$$

Where P is desired percentage of SNs to become CHs.

r is current round

G is the set of SNs that have not participated in CH selection process in previous $\frac{1}{P}$ rounds.

SN is elected as CH if its random number is less than threshold value $T(n)$.

SN is selected as secondary CH for every grid randomly. Secondary CH will act as primary CH only in case any grid left-out without CH selected through LEACH protocol.

Main feature of Grid-LEACH protocol is that in case any grid left without CH then secondary CH is elected for that grid.

Steady state phase: In steady phase CH collects data from its member sends aggregated data of its cluster to BS.

IV. SIMULATION AND RESULTS

Grid-LEACH protocol is implemented on MATLAB-R2021a. Simulation Parameters are shown in Table I.

After implementation of Grid-LEACH protocol, Simulations are shown in figure 2.

TABLE I: SIMULATION PARAMETERS

Simulation Parameter	Value
No. of Nodes(n)	500
Network Size	300*300
Base Station Position	150*150
P	0.3
Initial energy	0.5
Number of rounds	50

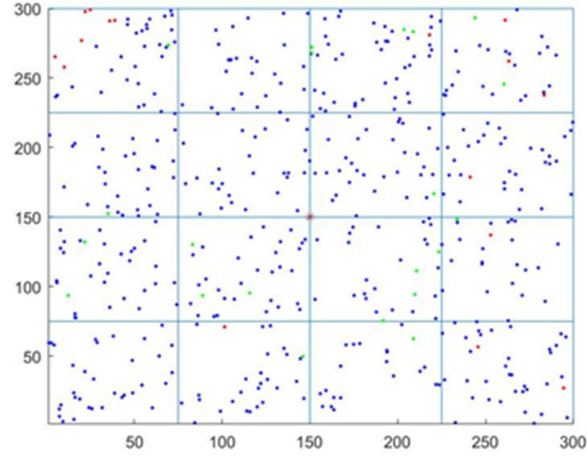


Figure 2: Network Topology

Simulation Results: Proposed Grid-LEACH Protocol is compared with LEACH protocol in terms of network lifetime. Network lifetime [14-17] is defined as average number of rounds until first node die. The comparison between LEACH and Grid-LEACH is shown in following figure 3: which shows that Grid-LEACH protocol has better network lifetime as compared to LEACH protocol because for every grid, CH is responsible for transmitting data to BS. As in case of LEACH if any grid left without CH; then nodes itself transmitted their sense data to BS thereby increasing the number of packets transmitted to BS and reducing energy efficiency of network.

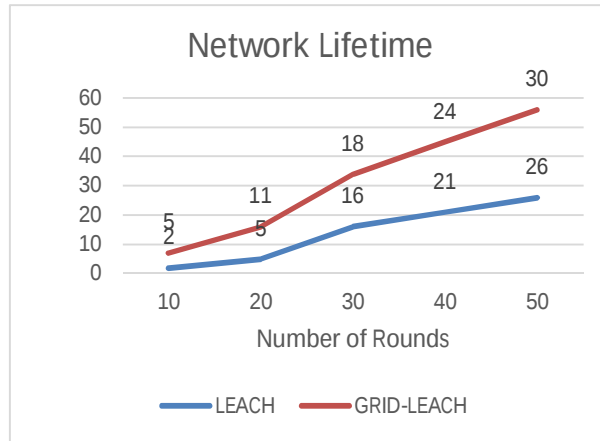


Figure 3: Comparison of Network Lifetime

V. CONCLUSION AND FUTURE WORK

In this paper we proposed a protocol named Grid-LEACH that mixes LEACH protocol with grid topology. Grid topology improves the energy efficiency by reducing communication energy. Main feature of Grid-LEACH

protocol is that in case any grid left without CH then secondary CH is responsible for transmitting aggregated data to BS. Simulation shows that Grid-LEACH perform better as compared to LEACH in terms of network lifetime by reducing the number of packets transmitted to BS and enhance the energy efficiency of network. Future work include implementation of Grid-LEACH protocol for heterogenous WSN.

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